Dendrochronological Analysis of Mont Alto, Pennsylvania Black Oak

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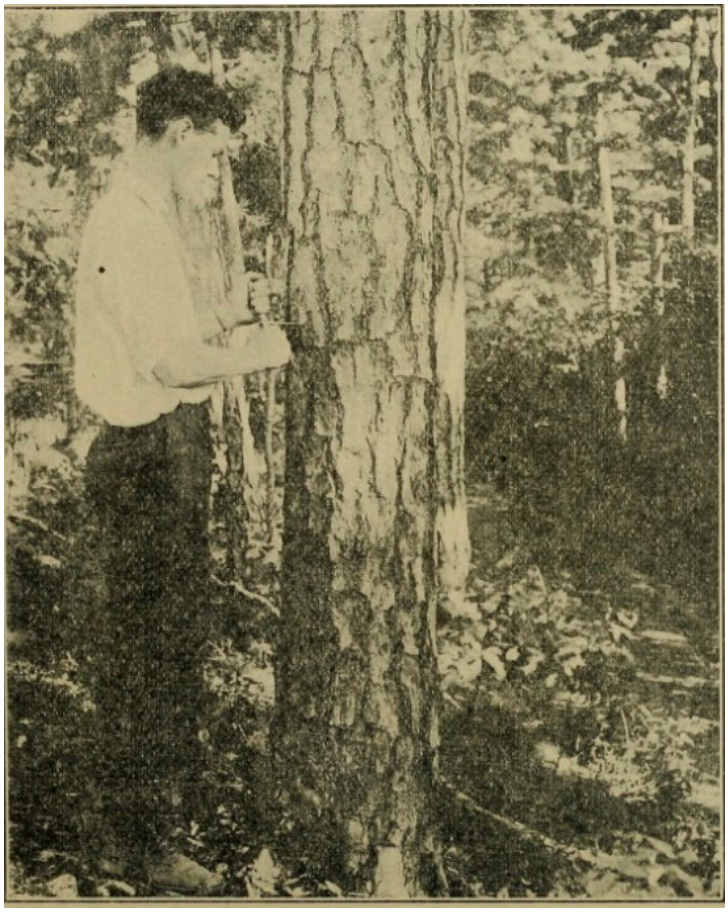

Image 1. Pennsylvania State Forest Academy student taking a core from a tree in Mont Alto, PA in 1922 (Pinchot, 1922)

I. Abstract

The specific tree of study, in this case, was from Mont Alto, Pennsylvania. This black oak (*Quercus velutina*) tree's champion size suggested it could be quite old, so this study was conducted to confirm its age. A sample of this tree was examined over several months. The rings were first counted by hand, determining that this black oak began its life in 1840, making it about 176 years old. The rings' widths were measured using a Velmex TA System to generate a figure illustrating the growth throughout its life and to confirm the age of the tree using cross dating, a standard dendrochronological method (Speer 2009). Once the growth pattern was determined, a general timeline of the events surrounding the life of this tree was produced. It was found that this black oak lived through the American Civil War, the Industrial Revolution until dying in 2017. During its lifetime, the tree recorded injuries to its trunk in 1903 and 1911. It also appears to have undergone a mortality spiral beginning in 2001.

Introduction

In 1817, John Funk constructed the first house on what is now known as Main Street, in a town that was once called Funkstown, which later became Altodale (Marotte 2016). Altodale and the adjacent area around Mont Alto Iron Works soon unified to become the town of Mont Alto, Pennsylvania. Iron Works furnaces were spread across Pennsylvania, producing charcoal from trees. Until about 1860, these furnaces were in substantial use, resulting in roughly an acre of forest being cleared per day (Cieri 2002). The company was so prevalent that the number of employees had grown to 500 (Marotte 2016) and logging became extensive across the state in the late 1800s.

In May of 1903, the Pennsylvania State Forest Academy in Mont Alto was initiated, in response to this deforestation, being one of the first forestry schools in the United States. Included in what now is known as Penn State Mont Alto is the university's arboretum. It began in 1905, on Arbor Day, with the collection of native tree specimens which surrounded the campus by students of the university (Cieri 2002). After the immense amount of deforestation that took place in Pennsylvania, trees became a crucial part of the state and the university. This report chronicles the growth history of a black oak tree that grew on land adjacent to Penn State Mont Alto. The large size of this tree (height: 110ft, circumference: 243 inches) led to its designation as the Champion Black Oak tree in Pennsylvania (Wade 2018) and to holding special value among the university community.

Black oak trees are prevalent in the eastern United States and thrive in full sun. Being amongst a plethora of other trees would inhibit the early growth of this species, as the canopy would not allow for sufficient sunlight to be provided for a black oak sapling. These trees prefer rich soils, though are typically found in drier regions, where forest cover is limited. Black oaks can grow over 100 feet tall and have diameters of at least three feet, and can live 200 years (Department of Horticulture 2018). A tree of this age may hold information which could give insight into the history of the agriculture of the surrounding land, as well as the successional forests by which it resides.

Materials/Methods

The first task in determining the significance of this specific tree was establishing its age. Since this black oak fell in early 2017, the outermost ring on the sample displayed a thin, latewood, ring, indicating its last period of growth in the last months of 2016. Through hand-counting of the tree's rings, about 176 were distinguished. Cross dating was also used to verify the age of the

tree. Cross dating is a basic technique used in dendrochronology that involves matching growth patterns of many trees of the same species through time. Since it involves the comparison of many trees, rather than the use of just one, it is a much more accurate technique than hand counting, which could result in error due to absent or false rings (Speer 2009). A single sample of the tree's radius was analyzed, having a width of about 3 feet.

The sample's ring widths were measured using a Velmex TA System. The information gathered was compared the series of events that occurred in Mont Alto during the growth of the black oak, influencing the widths of its rings. Cross-dating was conducted using the software program, COFECHA (Holmes 1983).

Results

This black oak tree began growing in 1840, amidst agricultural and political change and lived until early 2017. Given that the cross-section analyzed from this tree was location at a height of a meter or two above its base, it's estimated age would be a few years older than 177 years recorded from this cross-section and suggest that this tree was old relative to the typical lifespans of this species. The width measurements of the black oak's rings illustrated a variety of periods of growth. The early growth of the tree was rapid, specifically between the years of 1840 and 1859 suggesting that it began life in open canopy conditions as preferred by this species (Figure 1). However, after these years, growth began to decline until an eventual plateau for about 13 years in 1919 until 1932. Injuries during 1903 and roughly 1911 were observed on the cross-section, prior to the plateau in growth. A small split in the wood was observed before growth continued (Image 3). This gradual growth decrease is common in trees as additional ring widths are wrapped around a stem of increasing diameter. The rate increased steadily with few fluctuations until the year 2003 when there was a sudden decrease. Growth was minimal until the death of the black oak in early 2017. These factors indicate the possibility of a mortality spiral, when different events that occur throughout a tree's life contribute cumulatively to its death (Franklin et al. 1987). In early 2017, the tree succumbed to root rot while the soil had also become too saturated to support the root system of the tree any longer (Hook 2017). It's growth history also coincides with historical events such as the Industrial Revolution and the American Civil War.

While the cross-section showed a positive correlation (0.10) with a local white oak reference chronology from Nyesville, PA; the correlation was lower than typical to assure accurate cross dating (0.32). This weaker correlation is not unexpected given that that reference chronology has low sample replication (n=5 trees) and is a different species of oak. These factors weaken the expression of a common climate signal between the reference chronology and black oak cross-section.

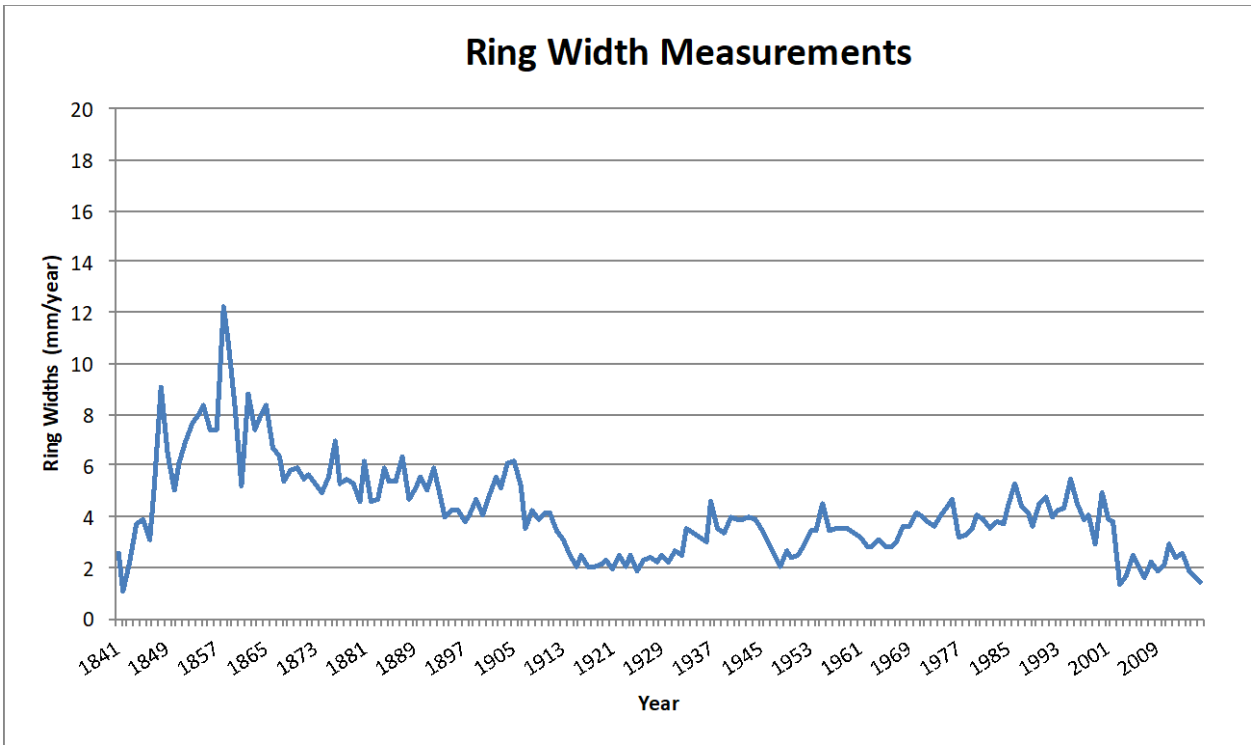

Figure 1. Velmex TA System ring measurement comparison.

Image 2. Aerial photograph of Mont Alto showing location of champion black oak tree, Pennsylvania 1938.

Image 3. Injuries at 1903 and 1913 on Mont Alto black oak cross-section

Image 4. Entire cross-section of Mont Alto black oak.

Image 5. Champion black oak in Mont Alto, Pennsylvania.

Discussion/Conclusion

The Industrial Revolution presented a large impact on the United States, and especially in Mont Alto, Pennsylvania, as the iron and charcoal trade became more widespread. Logging became a common practice as source of wood to make charcoal, which was then manufactured to produce iron through Iron Works, the primary iron production company in Mont Alto, Pennsylvania. This

suggests that any trees surrounding the young sapling could have been cut down for lumber, creating an optimal environment for a black oak, since they cannot thrive in shade. Whether or not this tree was in a popular area for logging, these results are clearly evidence that it was not growing in the presence of many other trees, and had fair access to sunlight and nutrients. Loggers began moving west around 1895, since the area in Pennsylvania and the rest of the eastern states had been mostly cleared. Around this time, the black oak's growth began to slow down. Most likely, this was due to more trees growing in place of any that were cut down.

The tree suffered from some kind of injury in 1903 as well as in 1913 (Image 3). As indicated in Figure 1, there was a large decline in development during these year and it slowed tremendously, most likely as a reaction to the injury in an attempt to recover. The plateau extends to about 1930, as this is the representation of very little growth. Following the recovery from this injury, development of this black oak was steady through the year 2002, before a sudden decline through 2003. This could have been the result of some other type of injury, or the point in time that root rot began to set in, hindering growth, leading to the tree's death in 2017.

Not only did the analysis on this tree provide insight into the environmental history of Mont Alto, but it helped strengthen our tree-ring based reference chronologies in south-central Pennsylvania. Few black oak trees have been sampled in Pennsylvania. Since each species records a different aspect of its surrounding climate, having this tree as part of a larger archive will improve our regional understanding of past environmental change in south-central Pennsylvania.

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